

washer under the bolt with a raised arrow on the crankcase cover (B, **Figure 185**). This washer is necessary to prevent an oil leak.

- c. Align the punch mark on the gearshift lever and shaft and install the lever. Tighten the bolt to the torque specification listed in **Table 2**.
- d. Make sure all electrical connections are free of corrosion and are tight.
- e. Install the foot peg assembly and tighten the bolts to the torque specification listed in **Table 2**.
- f. Fill the engine with the recommended type and quantity of engine oil as described in Chapter Three.

CRANKCASE AND CRANKSHAFT

Disassembly of the crankcase—splitting the cases—and removal of the crankshaft assembly require that the engine be removed from the frame.

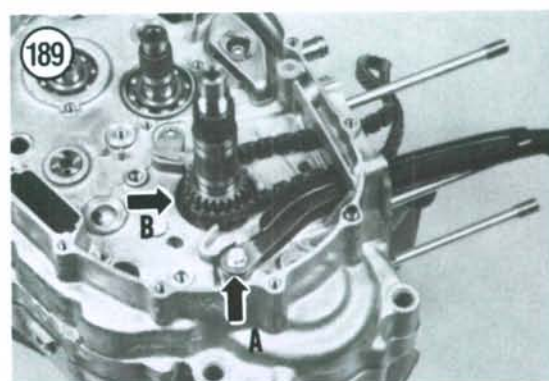
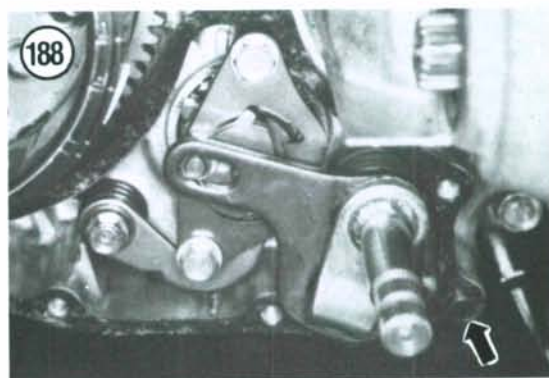
The crankcase is made in 2 halves of precision die cast aluminum alloy and is of the “thin-walled” type. To avoid damage, do not hammer or pry on any of the interior or exterior projected walls. These areas are easily damaged. The cases are split vertically down the centerline of the connecting rod. The cases are assembled with a gasket between the 2 halves and dowel pins align the halves when they are bolted together.

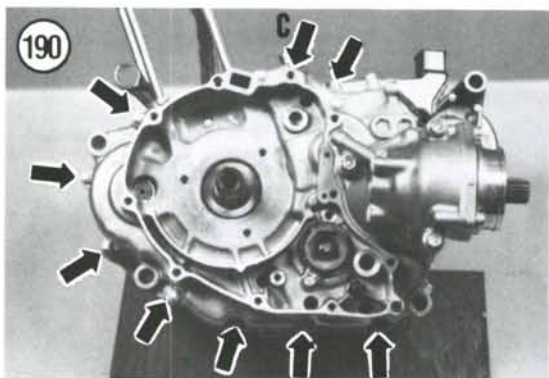
The crankshaft assembly is made up of 2 flywheels pressed together on a hollow crankpin. The connecting rod big end bearing on the crankpin is a needle bearing assembly. The crankshaft assembly is supported in 2 ball bearings in the crankcase. Service to the crankshaft assembly is limited to removal and replacement and must be performed by a dealer.

The procedure which follows is presented as a complete, step-by-step, major lower end rebuild that should be followed if an engine is to be completely reconditioned. However, if you’re replacing a part that you know is defective, the disassembly should be carried out only until the failed part is accessible; there is no need to disassemble the engine beyond that point so long as you know the remaining components are in good condition and that they were not affected by the failed part.

Crankcase Disassembly

1. Remove the engine as described in this chapter.
2. Remove all exterior engine assemblies as described in this chapter and other related chapters:
 - a. Cylinder head cover, camshaft and cylinder head.
 - b. Cylinder and piston.
 - c. Clutch assemblies.
 - d. Clutch release mechanism.
 - e. Kickstarter.
 - f. Alternator.
 - g. External shift mechanism.
 - h. Oil pump.
 - i. Starter motor and starter reduction gears.
3. If not already removed, remove the bolt (A, **Figure 189**) securing the camshaft drive chain tensioner arm and remove the camshaft drive chain tensioner arm and camshaft drive chain (B, **Figure 189**).
4. Before removing the crankcase bolts, cut a cardboard template approximately the size of the crankcase and punch holes in the template for each bolt location. Place each bolt in the template hole as it is





removed. This will speed up the assembly time by eliminating the search for the correct length bolt.

5. Remove the bolts that secure the crankcase halves together in 2-3 stages from the left-hand crankcase side. Refer to **Figure 190** and **Figure 191**. To prevent warpage, loosen them in a crisscross pattern. Refer to the "C" arrows on the figures for electrical wire clip locations.

NOTE

*Set the engine on 4 x 4 inch wood blocks or fabricate a holding fixture of 2 x 4 inch wood as shown in **Figure 192**.*

6. Turn the crankcase over and remove the only bolt (**Figure 193**) on the right-hand side.

CAUTION

*Perform the next step directly over and close to the workbench as the crankcase halves may separate easily. **Do not** hammer on the crankcase halves or they will be damaged.*

7. Hold onto the right-hand crankcase and studs and tap on the right-hand end of the crankshaft and transmission shafts with a plastic or rubber mallet until the crankshaft and crankcase separate.

8. Remove the right-hand crankcase half.

9. If the crankcase and crankshaft will not separate using this method, check to make sure that all bolts are removed. If you still have a problem, take the crankcase assembly to a dealer and have it separated. Do not risk expensive crankcase damage with improper tools or techniques.

NOTE

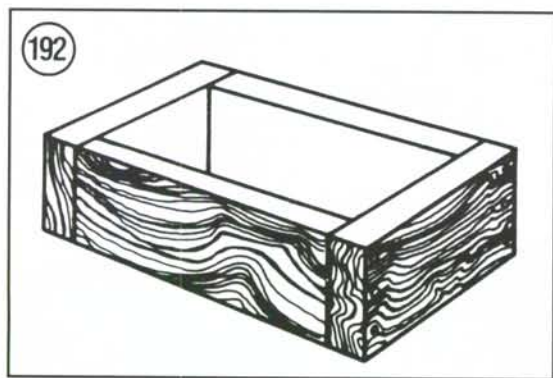
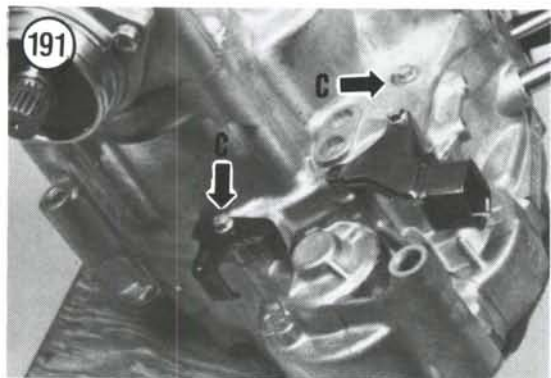
Never pry between case halves. Doing so may result in oil leaks, requiring replacement of the case halves.

10. Don't lose the locating dowels if they came out of the case. They do not have to be removed from the case if they are secure.

11. Disassemble the transmission, shift drum and shift fork shaft assemblies as described in Chapter Six.

12. The balancer (A, **Figure 194**) will *not* come out until the crankshaft (B, **Figure 194**) is removed.

13. The crankshaft must be pressed out and in of the left-hand crankcase half. This job should be entrusted to a dealer as special tools and a hydraulic press are required.



14. If necessary, remove the bolts (**Figure 195**) securing the output shaft assembly and remove the assembly. Don't lose the locating dowel and oil control orifice and O-ring in the crankcase.

15. Inspect the crankcase halves and crankshaft as described in this chapter.

Crankcase Assembly

1. Apply assembly oil to the inner race of all bearings in both crankcase halves.

NOTE

Set the left-hand crankcase half assembly (including the crankshaft and balancer) on wood blocks or the wood holding fixture shown in the disassembly procedure.

2. If the output shaft assembly was removed, perform the following:

- Apply a coat of fresh engine oil to the O-ring seal (**Figure 196**) on the output shaft assembly.
- Install the oil control orifice with a new O-ring (A, **Figure 197**) and the locating dowel (B, **Figure 197**) into the crankcase.
- Install the output shaft assembly onto the crankcase. Push the assembly as far as it will go.
- Install the bolts (**Figure 195**) securing the output shaft assembly. Gradually tighten the bolts in a criss cross pattern and pull the assembly down and into place on the crankcase. Tighten the bolts to the torque specification listed in **Table 2**.

3. Install the transmission assemblies, shift shafts and shift drum as described in Chapter Six.

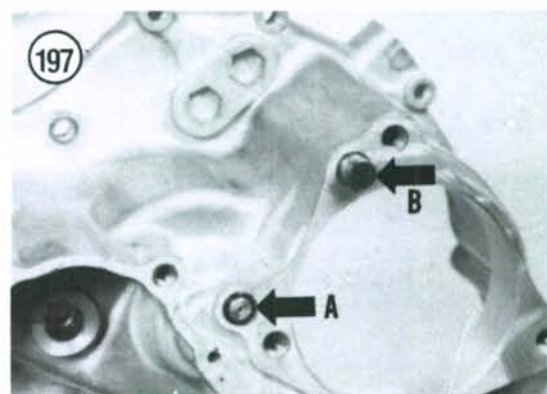
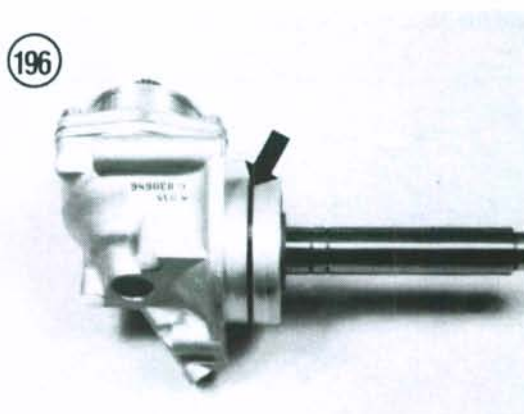
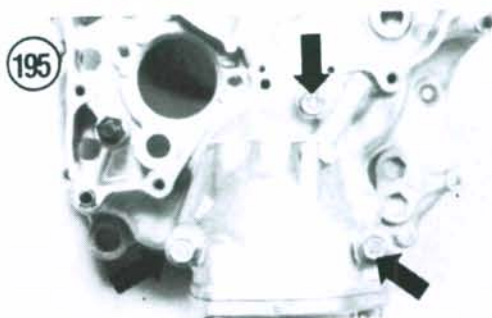
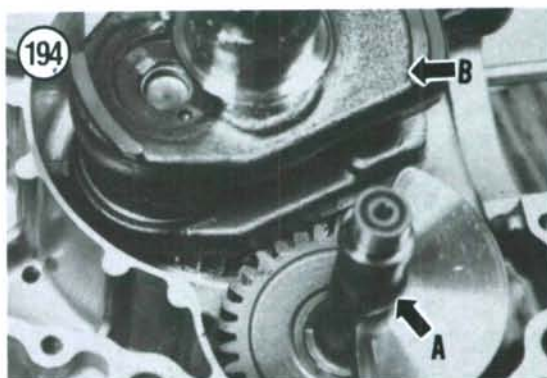
NOTE

Make sure the crankcase mating surfaces are clean and free of all old gasket material. Spray both surfaces with contact cleaner and wipe clean with a lint-free cloth. Make sure you get a leak-free seal.

4. If removed, install the locating dowels (A, **Figure 198**).

5. Install a new crankcase gasket (B, **Figure 198**).

6. Set the right-hand crankcase half over the left-hand side assembly on the wood blocks. Push it



down squarely into place until it reaches the crankshaft bearing. There is usually about 1/2 inch left to go.

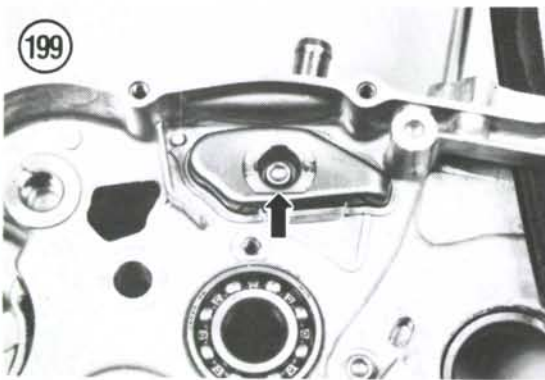
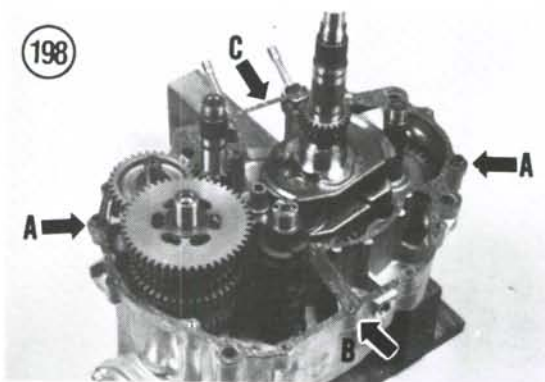
7. Lightly tap the case halves together with a plastic or rubber mallet until they seat.

CAUTION

Crankcase halves should fit together without force. If the crankcase halves do not fit together completely, do not attempt to pull them together with the crankcase screws. Separate the crankcase halves and investigate the cause of the interference. If the transmission shafts were disassembled, recheck to make sure that a gear is not installed backwards. Do not risk damage by trying to force the cases together.

8. After the crankcase halves are completely assembled, rotate the crankshaft and transmission shafts to make sure there is no binding. If any is present, disassemble the crankcase and correct the problem.

9. Install the bolts on the left-hand side that secure the crankcase halves together. Refer to **Figure 190** and **Figure 191**. Be sure to install all electrical wire



clips at the location shown with a "C" on these 2 **Figures**.

10. Securely tighten the screws in 2 stages in a crisscross pattern until they are firmly hand-tight.

11. Turn the crankcase over and install the only bolt on the right-hand side (**Figure 193**). Tighten this bolt firmly hand-tight also.

12. After the crankcase halves are completely assembled, again rotate the crankshaft and transmission shafts to make sure there is no binding. If any is present, disassemble the crankcase and correct the problem. Tighten the bolts on the right-and-left-hand side to the torque specification listed in **Table 2**.

NOTE

*After a new crankcase gasket has been installed, it must be trimmed. Carefully trim off all gasket material where the cylinder base gasket comes in contact with the crankcase (C, **Figure 198**). If the gasket is not trimmed, the cylinder base gasket will not seal properly.*

13. Feed the camshaft drive chain down through the top of the chain opening in the crankcase and install the camshaft chain onto the timing sprocket on the crankshaft (B, **Figure 189**). Make sure it is correctly engaged onto the timing sprocket.

14. Install the camshaft tensioner assembly and tighten the bolt (A, **Figure 189**) securely.

15. Install all exterior engine assemblies as described in this chapter and other related chapters:

- a. Starter motor and starter reduction gears.
- b. Oil pump.
- c. External shift mechanism.
- d. Alternator.
- e. Kickstarter.
- f. Clutch release mechanism.
- g. Clutch assemblies.
- h. Cylinder and piston.
- i. Cylinder head cover, camshaft and cylinder head.

Crankcase and Crankshaft Inspection

1. Remove the bolt (**Figure 199**) securing the crankcase breather baffle and remove the baffle.

2. Clean both crankcase halves inside and out with cleaning solvent. Thoroughly dry with compressed air and wipe off with a clean shop cloth. Be sure to

remove all traces of old gasket material from all mating surfaces.

3. Check the crankshaft, transmission and shift drum bearings (A, **Figure 200**) for roughness, pitting, galling and play by rotating them slowly by hand. If any roughness or play can be felt in the bearing it must be replaced as described in this chapter.

4. Carefully inspect the cases for cracks and fractures, especially in the lower areas; they are vulnerable to rock damage. Also check the areas around the stiffening ribs, around bearing bosses and threaded holes. If damage is found, have them repaired by a shop specializing in the repair of precision aluminum castings or replace them.

5. Make sure the crankcase studs (B, **Figure 200**) are tight in each case half. Retighten if necessary.

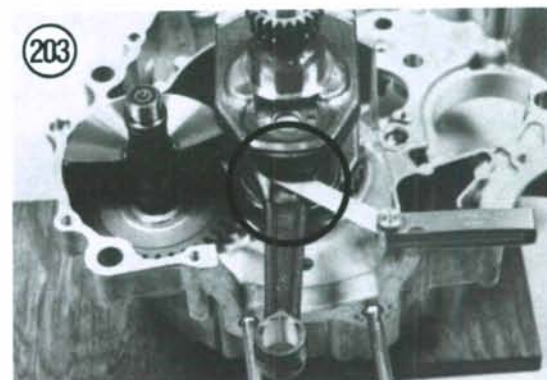
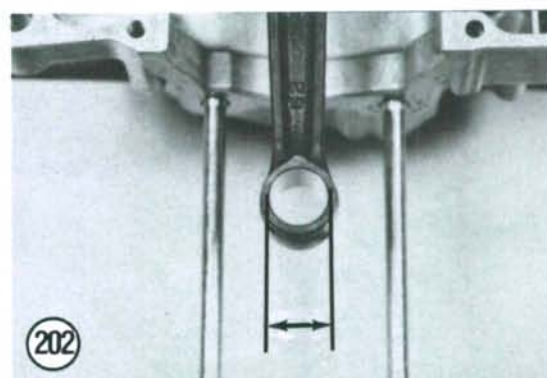
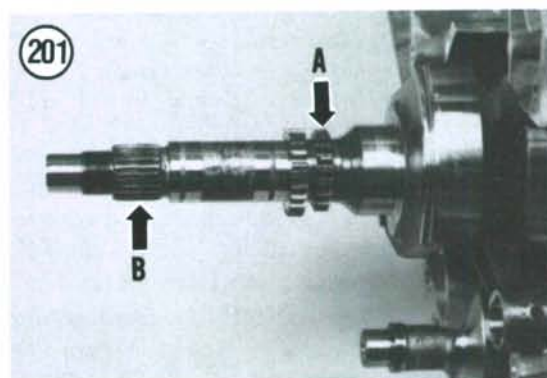
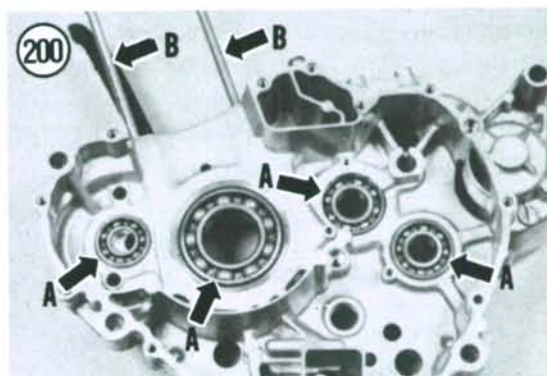
6. Inspect the camshaft chain sprocket (A, **Figure 201**) and centrifugal clutch splines (B, **Figure 201**) for wear or damage. If the sprocket is damaged, the sprocket may be replaced by a dealer. If the splines are damaged, the crankshaft must be replaced.

7. Measure the inside diameter of the connecting rod small end (**Figure 202**) with a snap gauge and an inside micrometer. Compare to dimensions given in **Table 1**. If worn to the service limit or greater, the crankshaft assembly must be replaced.

8. Check the connecting rod big end bearing by grasping the rod in one hand and lifting up on it. With the heel of your other hand, rap sharply on the top of the rod. A sharp metallic sound, such as a click, is an indication that the bearing or crankpin or both are worn and the crankshaft assembly should be replaced.

9. Check the connecting rod-to-crankshaft side clearance with a flat feeler gauge (**Figure 203**). Compare to dimensions given in **Table 1**. If the clearance is greater than specified, the crankshaft assembly must be replaced.

10. Other inspections of the crankshaft assembly involve accurate measuring equipment and should be entrusted to a dealer or competent machine shop. The crankshaft assembly operates under severe stress and dimensional tolerances are critical. These dimensions are given in **Table 1**. If any are off by the slightest amount it may cause a considerable amount of damage or destruction of the engine. The crankshaft assembly must be replaced as a unit as it cannot be serviced without the aid of a 9,000-11,000 kilogram (10-12 ton) capacity press, holding fixtures and crankshaft jig.



11. Inspect the oil seals. They should be replaced every other time the crankcase is disassembled. Refer to *Bearing and Oil Seal Replacement* in this chapter.

Bearing and Oil Seal Replacement

NOTE

The transmission mainshaft bearing and oil control orifice plate replacement should be entrusted to a dealer as special tools are required for removal and installation of the bearing and the plate. All other bearings can be removed in the normal way as described in this procedure.

1. Pry out the oil seals with a small screwdriver, taking care not to damage the crankcase bore. If the seals are old and difficult to remove, heat the cases as described in Step 2 and use an awl to punch a small hole in the steel backing of the seal. Install a small sheet metal screw part way into the seal and pull the seal out with a pair of pliers.

CAUTION

Do not install the screw too deep or it may contact and damage the bearing behind it.

CAUTION

There may be a residual oil or solvent odor left in the oven after heating the crankcases. If you use a household oven or microwave oven; first check with the person who uses the oven for food preparation to avoid getting into trouble.

2. The bearings are installed with a slight interference fit. The crankcase must be heated in an oven (or microwave) to a temperature of about 100° C (212° F). An easy way to check the proper temperature is to drop tiny drops of water on the case; if they sizzle and evaporate immediately, the temperature is correct. Heat only one case at a time.

CAUTION

Do not heat the cases with a torch (propane or acetylene); never bring a flame into contact with the bearing or case. The direct heat will destroy the case

hardening of the bearing and will likely cause warpage of the case.

3. Remove the case from the oven and hold onto the 2 crankcase studs with a kitchen pot holder, heavy gloves or heavy shop cloths—it is hot.
4. Remove the oil seals if not already removed (see Step 1).
5. Hold the crankcase with the bearing side down and tap it squarely on a piece of soft wood. Continue to tap until the bearing(s) fall out. Repeat for the other half.

CAUTION

Be sure to tap the crankcase squarely on the piece of wood. Avoid damaging the sealing surface of the crankcase.

6. If the bearings are difficult to remove, they can be gently tapped out with a socket or piece of pipe the same size as the bearing outer race.

NOTE

If the bearings or seals are difficult to remove or install, don't take a chance on expensive damage. Have the work performed by a dealer or competent machine shop.

7. While heating up the crankcase halves, place the new bearings in a freezer if possible. Chilling them will slightly reduce their overall diameter while the hot crankcase is slightly larger due to heat expansion. This will make bearing installation much easier.
8. While the crankcase is still hot, press each new bearing(s) into place in the crankcase by hand until it seats completely. Do not hammer it in. If the bearing will not seat, remove it and cool it again. Reheat the crankcase and install the bearing again.
9. Oil seals are best installed with a special tool available at a dealer or motorcycle supply store. However, a proper size socket or piece of pipe can be substituted. Make sure that the bearings and seals are not cocked in the crankcase hole and that they are seated properly.

BREAK-IN PROCEDURE

If the rings were replaced, a new piston installed, the cylinder rebored or honed or major lower end work performed, the engine should be broken in just

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